

**AMENDMENTS****IN THE SPECIFICATION**

Please amend the paragraph beginning at page 1, line 13 as follows:

Electronic phase shifters are used in many devices to delay the transmission of an electric signal. Waveguide phase shifters have been described in United States Patents No. 4,982,171 and 4,654,611. United States Patent No. 4,320,404 discloses a phase shifter using diode switches connected to wire conductors inside a waveguide that are turned on or off to cause a phase shift of the propagating wave. United States Patents No. 4,434,409; ~~4,532,704~~ 4,532,704; 4,818,963; 4,837,528; 5,724,011 and 5,811,830 disclose tuning ferrites, ferromagnetic or ferroelectric slab materials inside waveguides to achieve phase shifting. United States Patents No. 4,894,627; 4,789,840 and 4,782,346 disclose devices that use finline structures to build couplers, signal detectors and radiating antennas. These patents either use slab material in a waveguide to construct phase shifters or use finlines for some other application.

Please amend the paragraph beginning at page 2, line 3 as follows:

Dielectric materials including barium strontium titanate are disclosed in U.S. Patent No. 5,312,790 to Sengupta, et al. entitled "Ceramic Ferroelectric Material"; U.S. Patent No. 5,427,988 to Sengupta, et al. entitled "Ceramic Ferroelectric Composite Material-BSTO-MgO"; U.S. Patent No. 5,486,491 to Sengupta, et al. entitled "Ceramic Ferroelectric Composite Material

- BSTO-ZrO<sub>2</sub>”; U.S. Patent No. 5,635,434 to Sengupta, et al. entitled “Ceramic Ferroelectric Composite Material-BSTO-Magnesium Based Compound”; U.S. Patent No. 5,830,591 to Sengupta, et al. entitled “Multilayered Ferroelectric Composite Waveguides”; U.S. Patent No. 5,846,893 to Sengupta, et al. entitled “Thin Film Ferroelectric Composites and Method of Making”; U.S. Patent No. 5,766,697 to Sengupta, et al. entitled “Method of Making Thin Film Composites”; U.S. Patent No. 5,693,429 to Sengupta, et al. entitled “Electronically Graded Multilayer Ferroelectric Composites”; and U.S. Patent No. 5,635,433 to Sengupta, et al. entitled “Ceramic Ferroelectric Composite Material-BSTO-ZnO”. These patents are hereby incorporated by reference. Copending, commonly assigned ~~United States patent application Serial No. 09/594,837~~ U.S. Patent No. 6,514,895 to Chiu et al. titled “Electronically Tunable Ceramic Materials Including Tunable Dielectric And Metal Silicate Phases”, filed June 15, 2000, and ~~Serial No. 09/768,690~~ U.S. Patent No. 6,744,077 to Sengupta et al. titled "Electronically Tunable Low-Loss Ceramic Materials Including a Tunable Dielectric Phase and Multiple Metal Oxide Phases", filed January 24, 2001, disclose additional tunable dielectric materials and are also incorporated by reference. The materials shown in these patents exhibit low dielectric loss and high tunability. Tunability is defined as the fractional change in the dielectric constant with applied voltage.

Please amend the paragraph beginning at page 4, line 19 as follows:

FIG. 2 is a side elevation view of a finline structure 34 that may be used in the phase

shifter of FIG. 1, and FIG. 3 is a cross-sectional view of the finline structure 34 taken along line 3-3 in FIG. 2. Finline structure 34 includes a low dielectric constant, low loss substrate 40 (see FIG. 3) with a layer of tunable material 42 deposited thereon. The preferred embodiment of this invention utilizes MgO as the substrate material. The tunable material is metalized with conductive material to form electrodes 46 and 48 that define a gap 44, which separates the electrodes 46 and 48 on the tunable material layer, as best shown in FIG. 3. The gap extends longitudinally from a first end 50 to a second end 52 of the structure. The gap includes a central portion 54 and first and second exponentially tapered end portions 56 and 58 respectively (see FIG. 2). The end portions are tapered such that the gap widens near the ends to provide impedance matching. Referring to FIG. 1, conductive plates 24 and 26 form exponentially tapered gaps 60 and 62 to provide additional impedance matching. Gaps 60 and 62 lie adjacent to the ends of gap portions 56 and 58 respectively. A plurality of openings, for example 64, 66 and 68, are located in the various components of the phase shifter of FIG. 1 for receiving fasteners that will be used to hold the phase shifter together.

Please amend the paragraph beginning at page 5, line 1 as follows:

The finline structure is constructed in a unilateral configuration, and in this example, no circuit or metalization is on the rear surface of the substrate 40. The tunable dielectric film on the front of the finline structure is metalized to form two electrodes 46 and 48 (as shown in FIGs. 2 and 3). In the preferred embodiment, the tunable dielectric film can be a thin film

ranging from 0.2 to 2.0  $\mu\text{m}$  in thickness, or a thick film ranging from 2 to 30  $\mu\text{m}$  in thickness, with a dielectric constant ranging from 30 to 2000. The exponentially tapered gaps in the metalization on the tunable dielectric material match the impedance at the ends to that of the center tunable region. The center tunable region includes a gap 54 (see FIG. 2) between two generally parallel edges of the metalized conductors with the width of the gap ranging from about 2 to about 50  $\mu\text{m}$  to form a capacitor. At each end of the tuning region, the same matching structure is mirrored to convert the impedance to that of the free space waveguide.

Please amend the paragraph beginning at page 5, line 21 as follows:

FIG. 6 is graph of the losses versus bias voltage for a phase shifter constructed in accordance with the invention. Curve 74 represents the calculated loss tangent ( $\tan\delta$ ). Curve 74 78 represents the test results of a phase shifter with a calculated conductor loss  $S_{21}$  dB. Curve 76 represents the measured test results of a phase shifter configured according to the present invention with a biasing voltage applied to yield a conductor loss  $S_{21C}$  dB. Conductor loss  $S_{21C}$  dB is less than calculated conductor loss  $S_{21}$  dB (curve 78) device total loss.

Please amend the paragraph beginning at page 6, line 26 as follows:

FIG. 8 is a side elevation view of a finline structure 94 that may be used in the phase shifter of FIG. 7, and FIG. 9 is a cross-sectional view of the finline structure 94 taken along line

9-9. Finline structure 94 (see FIG. 7) includes a low dielectric constant, low loss substrate 96 (see FIG. 9) with a layer of tunable material 98 (see FIG. 9) deposited thereon. The preferred embodiment of this invention utilizes MgO as the substrate material. The tunable material is metalized with conductive material to form electrodes 100 and 102 that define a gap 104, which separates the electrodes 100 and 102 on the tunable material layer (as best seen in FIG. 8). The gap extends longitudinally from a first end 106 to a second end 108 of the structure. The gap includes a central portion 110 and first and second exponentially tapered end portions 112 and 114 respectively. The end portions are tapered such that the gap widens near the ends to provide impedance matching. Electrode 102 has a relatively large surface area so that it provides an RF ground to the waveguide structure. In addition, in the embodiment shown in FIG. 8, electrode 102 includes an RF choke design 116 to ensure the RF ground and DC isolation.

Please amend the paragraph beginning at page 7, line 6 as follows:

The embodiment shown in FIGs. 7, 8 and 9 uses a spring loaded contact 118 to connect the bias voltage from voltage source 120 to one of the metalized layers on the tunable material (as shown in FIG. 7). This design reduces the size and simplifies the structure. Furthermore, the first electrode 100 is DC grounded, while the second electrode 102 is DC biased and forms an RF ground. The RF ground can be provided via the large area of electrode, or through an RF choke design as shown in FIG. 8, on the substrate to ensure an RF ground.

Please amend the paragraph beginning at page 7, line 12 as follows:

FIG. 10 is an exploded isometric view of another tunable phase shifter 122 constructed in accordance with another alternative embodiment of the invention. The phase shifter 122 includes a waveguide 124 including side portions 126 and 128. Side portion 126 includes a longitudinal groove 130 and side portion 128 includes a longitudinal groove ~~1320~~ 132. When the side portions are brought together, the grooves form a channel 134. A finline structure 136 is positioned between the side portions of the waveguide.

Please amend the paragraph beginning at page 7, line 18 as follows:

FIG. 11 is a side elevation view of a finline structure 136 that may be used in the phase shifter of FIG. 10, and FIG. 12 is a cross-sectional view of the finline structure 136 taken along line ~~12-12~~ 11-11 (in FIG. 11). Finline structure 136 includes a low dielectric constant, low loss substrate 138 with a layer of tunable material 140 deposited thereon (as shown in FIG. 12). The preferred embodiment of this invention utilizes MgO as the substrate material. The tunable material is metalized with conductive material to form electrodes 142 and 144 that define a gap 146, which separates the electrodes 142 and 144 on the tunable material layer (best shown in FIG. 11). The gap extends longitudinally from a first end 148 to a second end 150 of the structure. The gap includes a central portion 152 and first and second exponentially tapered end portions 154 and 156 respectively. The end portions are tapered such that the gap widens near

the ends to provide impedance matching.

Please amend the paragraph beginning at page 7, line 29 as follows:

The embodiment shown in FIGs. 10, 11 and 12 uses a spring loaded contact 158 to connect the bias voltage from voltage source 160 to one of the metallized layers on the tunable material **(as shown in FIG. 10)**. This design reduces the size and simplifies the structure. Furthermore, the first electrode is DC grounded, while the second electrode is DC biased with an RF ground. The RF ground can be provided via the large area of the electrode, or by an RF choke design on the substrate to ensure RF ground and DC isolation.